Meeting Minutes
Moab Project Site Groundwater Subcommittee
Moab, Utah

July 12, 2002, 8:30 am – 4:30 pm

Meeting Attendees

Bruce Waddell, U.S. Fish and Wildlife Service
Harvey Merrell, Local Citizen & Stakeholder
Joel Berwick, U.S. Department of Energy, Grand Junction Office (DOE-GJO)
Kim Schappert, Grand County Council
Ken Karp, MACTEC-ERS
Don Metzler, DOE-GJO
Toby Wright, MFG, Inc.
Max Young, Utah State Representative
Audrey Berry, DOE-GJO
Pete Penoyer, U.S. National Park Service
Damian Fagan, The Nature Conservancy
John Elmer, MACTEC-ERS
Frank Gardner, Kayenta Consulting
Loren Morton, Utah Division of Radiation Control

Field Visit (8:30 to approximately 11:00 am) – visits were made to several locations outside the restricted area at the Moab Project Site, including:

1. Bedrock Well 434 – observations were made of drill core samples and sonic drilling equipment and methods at a drill site North of Highway 191 and West of the Courthouse Wash parking lot. DOE staff reported the water table surface was found at a depth of about 40 feet below ground surface (ft bgs) in well 434. Colorado River gravels were observed in core samples at a depth of about 52 to 60 ft bgs, as indicated by rounded igneous and metamorphic rock clasts that are not indigenous of rock formations found in the Moab Wash drainage. These gravels along with brownish gray, finer-grained (overbank) deposits of the Colorado River occurred between the distinctive red units of colluvium and Moab/Courthouse Wash alluvium (above) and the underlying red to maroon bedrock units of the Glen Canyon Group. It was apparent that a thorough analysis of these cores and the additional cores planned both through and beneath the tailings pile, could provide important site characterization information and place the movements of the Colorado River in a better historical context. DOE staff also reported that bedrock formations were found in well 434 at the following depths:

   - Wingate Sandstone (Glen Canyon Group) = 60 ft bgs
   - Chinle Formation = 75 ft bgs

   DOE staff reported that the screen in this well will be set between 75 – 85 ft bgs.

2. River Intake Structure - of the Future Freshwater Application project, located at the mouth of Moab Wash. Intake structure and piping installed from river to bench near DOE well 406. Pump and distribution pipe to be installed later after river level rises sufficient to create backwater habitats.

There were sidebar discussions in several small groups. One topic included the possible need to document or monitor (synoptically) ammonia discharges under the extreme low flow conditions likely to develop further into the summer and fall. This would be done to determine if the effects of the groundwater plume discharge to the Colorado River waters may be apparent further down stream (near bank shallows) and if ammonia concentrations in the main channel (bottom area) were now apparent due to limited dilution and the possible increase of groundwater discharge under the low stream flow conditions. Representatives of DOE indicated this may be warranted and would take into consideration some limited, probe-based (temperature, specific conductance, pH, and ammonia) synoptic monitoring effort in lieu of the monitoring postponed in the planned initial action.

3. Backwater Habitat Areas – near and downstream of the Moab Wash delta, now left high and dry by the low flow stage of the Colorado River. First year tamarisk growth was found dense and about 3 to 4 feet high in these areas. Several other areas at or near river level were covered with a moderate amount of an evaporite (gypsum?) crust.

Subcommittee Meeting (about 11:00 am to 4:30 pm) – held in the Grand County Council Room. A summary of discussions and presentations made follows below. Comments provided to DOE by Subcommittee members are listed in italics.

1. National Academy of Science (NAS) Report [Dated 6/11/02] – Joel Berwick (DOE-GJO)

In general there were no surprises in the NAS report. In reviewing the report, DOE identified 24 action items that NAS suggested DOE consider. Several of these are related to ground and surface water quality, including:

- Determination of impact of tailings seepage / groundwater pollution (primarily ammonia) on benthic community at base of river.
- Evaluation of tailings pile failure scenarios, including pile erosion and river migration and potential downstream impacts/effects.
- Investigate unconsolidated slimes under the tailings pile to determine their effect on leachate seepage from the tailings to groundwater and place a bound on seepage rate.
- Evaluate an enhanced cover design

Overall, NAS identified a need for a greater amount of and more robust technical data upon which to base remedial decisions beyond that data set inherited from the NRC. DOE acknowledged that there are no major disagreements with the conclusions of the NAS report. DOE indicated they were first briefed by the NAS on the report contents on June 11 prior to the NAS holding a public meeting on their report results on June 13.

DOE is developing a proposal, including scope and estimated costs, for responding to the NAS comments. Near the end of July, 2002 DOE will determine the cost, scope of work, and schedule for investigating and resolving the 24 NAS Action Items[1]. DOE is operating

[1] This proposal was sent to DOE Headquarters for review on July 22, 2002. Action on this proposal is pending Headquarters review.

under the assumption that the former DOE deadline for completion of a Remediation Plan (November 8, 2002) will likely be delayed. DOE indicated that the transition from their previous contractor (MACTEC-ERS) working at the site to the winner of the new DOE contract (Stoller team) would be completed over the next week or so. Very limited personnel changes are anticipated and a smooth transition is expected.

Also, DOE-GJO is evaluating enhanced conceptual cover designs for both on-site and off-site stabilization in two ways: 1) made more robust by decreasing the clay radon barrier permeability, and 2) by adding a moisture storage layer below the riprap and above the clay radon barrier [2]. Weighing lysimeter studies are in progress at the Monticello site to evaluate the moisture retention and drainage properties of this revised DOE-GJO on-site cover design. Also seepage studies/evaluations of the pile will consist of two parts: 1) predict under the present transient conditions how long it takes for the seepage to reach steady state through asymptotic decline and 2) establish how long the long-term seepage will continue to occur at a constant rate under the cap in place scenario.

2. Ground Water and Tailings Pile Characterization Work Plan [Dated 6/02] – Don Metzler (DOE-GJO) and Ken Karp (MACTEC-ERS)

   This investigation is currently on-going and includes four phases of effort, each outlined below:

   A. Phase 1: Nested Piezometers Near River – including installation of three piezometer nests near the Colorado River to determine vertical hydraulic gradient at these locations. Drilling method = auger. These three piezometer nests (of three wire transducer each) are currently in operation at the site. Each piezometer nest was installed in a single uncased borehole, with each depth interval instrumented with a vibrating wire transducer to measure groundwater pore pressure. The transducer instruments do not require installation in separate casings but are positioned at separate depths with each connected to the surface by a separate electrical cable.

   B. Phase 2: Nested Tailings Pile Piezometers – includes installation of nested piezometers at three locations in tailings pile to determine vertical hydraulic gradient inside tailings. Drilling method = direct push. These tailings piezometers are currently in operation. Initial head measurements indicate that the tailings leachate is being drawn or forced upward through the vertical band drains (wicks) and evaporated at the tailings surface. Initial pore pressure measurements indicate that the tailings leachate continues to be evacuated or forced upward via the vertical band drains (wicks) to the surface from residual effects of additional overburden applied to the pile previously by the Trustee. The leachate is collected in a flexible membrane lined pond on the tailings pile surface and evaporated. DOE is considering making an upgrade to the wick drain collection sump by installing a low flow, continuous pump and dedicated power. This operational improvement provides regular evacuation of the sump and should increase the volume of leachate removed and evaporated from the tailings pile.

[2] A third option has also become apparent since the July 12, 2002 meeting, in that radon barrier thickness could also be increased.

C. Phase 3: Subsurface Electrical Conductivity Measurements and Transects – includes direct push boreholes and measurements of formation electrical conductivity at various depths in the subsurface to characterize freshwater, transition and brine zones. These three transects are located North and Northeast of the pile. The objective of this work was to measure and develop a quasi three-dimensional vertical profile of the freshwater / brine interface in the groundwater system under the site.

   Initially a comparison test was conducted in the floodplain area near the DOE well nest at PW-01. From this initial work, a good correlation appeared between groundwater conductivity collected from water quality samples from the PW-01 site and the more recent direct-push soil conductivity measurements. DOE-GJO reported that at the time of the meeting, this phase of the investigation was about two or three days away from completion. DOE also reported that this direct push probe investigation saw limited success, in that many of the drilling locations met with refusal during drilling (presumably by coarse gravels) before reaching optimal depth [3]. As a result, DOE may have to rely on data from the deep alluvial wells and screening level grab samples from the bedrock drilling program, to better profile subsurface conductivity and the freshwater / brine groundwater interface.

D. Phase 4: Bedrock Borings and Paired Bedrock / Alluvial Wells – DOE-GJO reported that this phase of the investigation had only just begun as observed earlier that morning by the Subcommittee at the first bedrock well location 434. DOE-GJO staff reported that bedrock well 434 would be screened across bedrock units at a depth of about 75 to 85 ft bgs. DOE also explained that the work plan was flexible, and that a shallow alluvial well will be installed at a later date in a location immediately adjacent to bedrock well 434. At that time, the shallow alluvial well will be completed with a screen across the layer of Colorado River gravel found at a depth of about 52 to 60 ft bgs.

   DOE also explained how bedrock borings would be drilled thru the tailings pile. Later these borings, after collecting core samples, will be sealed and completed as shallow alluvial wells under the pile. DOE also added that great care would be taken to fully grout these wells across the tailings intervals in order to prevent construction of any annular conduit that could accelerate the release of seepage to the underlying groundwater. Subcommittee participants generally acknowledged that DOE's efforts to collect this subpile data is a critical element in meeting NAS recommendations for a more complete site characterization and warranted the risks associated with drilling through and beneath the pile. Only limited investigations beneath the pile had been undertaken previously and this restricted earlier attempts to more fully characterize the site.

DOE-GJO also explained that the fieldwork for all four phases of this investigation will be done by about mid-August. Thereafter, it may take about three months to compile the data, perform preliminary analysis, and generate a preliminary report of the findings (calculation set) for this new work (mid-November). They also indicated that some vertical characterization of the groundwater and tailings pore fluids was planned and that collection of water samples using hydro-punch or alternate method was under consideration. Analyses for Contaminants of Concern (COCs) and specific conductivity will likely be performed.

[3] Since the July 12, 2002 meeting, DOE was able to advance all the direct-push probes planned; with the exception of one site where it was refused by cobble sized gravel.

Packer tests of the three bedrock completions across the northern part of the site will also be conducted.

Subcommittee Comments: Groundwater and Tailings Pile Characterization Work Plan – included the following:

1) *Request for Progress Reports – progress reports should be provided to the Subcommittee to allow members to stay abreast of the latest developments of the ongoing investigations at the site. DOE-GJO agreed to consider this request and added that it may be more feasible for them to submit "calculation sets" that provide various computations based on this data and outline the (raw) data that has been gathered. It was requested that figures and maps also attend any data provided, so as to improve the communication process. It was decided that the preliminary results of the current drilling program will be distributed to the Subcommittee in advance, followed by a DOE presentation at the next Subcommittee meeting.*

2) *Request for Well Completion Diagrams and Geologic Logs – as new wells are installed, DOE-GJO should provide detailed well completion diagrams and geologic logs with each progress report or "calculation set". DOE-GJO agreed to do this.*

3) *Request for Well / Boring Locations – Harvey Merrell requested that the survey coordinates and elevations be included on all the well logs and boring diagrams generated for investigations at the site. DOE-GJO indicated that this is their standard practice and committed to continue to provide this information with all new well completion diagrams and geologic logs provided to the Subcommittee.*

4) *Use of 2-inch Diameter Casing for Shallow Aquifer Wells Under Tailings Pile – DOE-GJO should consider increasing the diameter of the casing to 4-inch or more for the shallow alluvial wells to be completed thru the tailings pile. Based on available information, DOE may have to lift water nearly 100 feet to sample these wells. A larger diameter casing in this case will facilitate and expedite future groundwater quality sampling in these wells. DOE agreed to consider this argument and/or provide information on appropriate sampling technologies now available for smaller diameter wells to these depths [4].*

5) *Error for Atlas Boring TH-27 – A previous DOE report states that Atlas boring TH-27 encountered a bedrock formation in the subsurface. However, review of a summary table in the July, 1994 Canonie Environmental Report (Table 1) shows that this boring did NOT encounter any bedrock material. DOE agreed to evaluate the apparent discrepancy.*

6) *Calibration of Specific Conductance –A question arose as to why well PW-02 was selected to calibrate the specific conductance equipment used in the direct push profiling? DOE staff explained that "calibration" was a misnomer in that DOE's intention was to advance a direct-push probe near existing well PW-02 with the intent of*

[4] After discussing this issue with the field sampling technicians, DOE is confident that 2-inch wells can be installed, developed, sampled, and geophysically logged if needed. Therefore, DOE plans to proceed with installation of 2-inch-diamter wells through the tailings.

comparing the specific conductance profile from this technology against know specific conductance data gathered from discrete vertical interval via wells and/or piezometers.

7) *Longevity and Reliability of Vibrating Wire Transducers (VWT) – DOE-GJO was queried as to the track record regarding the longevity and reliability of these types of transducers in corrosive environments such as brines and acidic groundwater? DOE staff explained that this technology has been applied elsewhere in the low-pH environments of mine tailings, and that should the device be compromised by corrosion, it simply fails to respond. No gradual degradation of signal has been observed under such circumstances that would lead to unreliable or corrupted pressure readings. However, because multiple units are installed inside of a single borehole and not in separate PVC casings, it appears that if one transducer fails, the entire nest will need to be replaced [5]. There is also a need for adjustment of the recorded pressure to a true freshwater head when waters of varying densities occur in the subsurface above the transducer. DOE was asked to clarify the relationship between measured pressure with the VWTs, the equivalent freshwater head, and associated vertical gradients at the site in the future analyses of these data.*

8) *Concerns with Integrity of Multiple Piezometers Installed in the Same Boring – An issue was raised concerning the DOE report that outlines how the three nests of new piezometers installed near the river were VWT devices installed in the same boring. There were questions as to what assurance the subcommittee has that there is no hydraulic connection between the different horizons instrumented? DOE staff explained that at the time of installation that bentonite plugs were installed between each vertical horizon where a VWT device was installed. Further, DOE's recent readings from the VWTs indicate that each depth has a different pore pressure, thus indicating that each device is hydraulically isolated from the others in each boring.*

3. Sensitivity Analysis of Groundwater Flow and Transport Models [Dated 6/02] – Don Metzler (DOE-GJO) and Ken Karp (MACTECH-ERS)

DOE staff explained that both of the former groundwater flow and transport models, completed for the Moab Project Site by the NRC and Shepherd Miller Inc (SMI) had used the USGS code Modflow. However, in the SMI model, the depth of the freshwater / brine interface had been estimated below the site with a Fortran program called Modbrine, and then set as a fixed basal no-flow boundary condition in their model. Other differences were outlined between the NRC and SMI models. These differences (source term, recharge from bedrock units, site water balance) resulted from the limited availability of direct measurements to support their calculation (or accurate estimation) and led to potentially significant differences in model output. This was also an area of concern expressed in the NAS report they included:

A. Recharge from Bedrock – the SMI model included a large amount of bedrock recharge entering the model domain from both laterally (North to South), and vertically upwards. Due to this differing recharge and different aquifer parameters assigned, the SMI model

[5] Upon further reflection DOE adds that if a tranducer fails, it can be replaced in an immediately adjacent boring with the other original transducers remaining in-place.

exhibited an overall water budget that included about 10-times more annual groundwater flow thru the model domain than the NRC model.

B. Boundary Conditions – the NRC model assumed a constant head boundary exists at the alluvial / bedrock contact North of the pile. Also, the NRC model did not include any simulation of variable density effects at the freshwater / brine interface found at depth under the site. DOE staff concluded that the NRC model had over-prescribed the boundary conditions assigned.

C. Wick Drain Effects – It was unclear what effects this removal of leachate would have on the overall source term for the site. This remedial action was hampered by its incomplete execution (addition of overburden to the pile was not completed) and failure to monitor historic volumes of leachate removed from the pile through this action. Its currently estimated by DOE-GJO that the leachate removal rate by the wick drains is approximately 2 gpm or about 10,000 gals/week with roughly a possible 15 million gallon volume of initial leachate stored in the tailings pile at the start of this action.

DOE staff also reported that for both models that insufficient geologic and hydrologic data were available from the site to allow calibration of either model to local groundwater flow conditions. Lacking this degree of control, neither model could be considered representative of actual field conditions at the Moab site and that further modeling is warranted after collection of data from the ongoing investigations.

A lack of groundwater quality compliance was also apparent for both models under all simulation scenarios tested, including the No-Action Alternative, the Cap-in-Place Alternative, and the Source Removal Alternative [6].

DOE staff also outlined how neither the NRC nor the SMI model had been capable of simulating dynamic density driven groundwater flow and contaminant transport that is anticipated at the Moab Project Site. To resolve this problem, DOE has examined the models available and is considering use of another USGS code called Seawat.

Subcommittee Comments: Sensitivity Analysis of Models – comments offered by Subcommittee members include the following:

1) *Importance of Ongoing Bedrock Characterization – the bedrock wells currently being drilled at the site are critical to an understanding of local subsurface recharge and flow system geometry*

2) *Tamarisk Evapotranspiration and Contaminant Uptake – the SMI model called on a "negative recharge" term to estimate the amount of water up-taken by tamarisk next to the Colorado River. It would appear that this sink term might be important to the upcoming DOE model, both for groundwater flow and contaminant mass transport and fate predictions.*

[6] Neither the NRC or the SMI model shows that natural flushing will be effective as a stand-alone strategy for removing uranium concentrations to levels below the 0.044 mg/l groundwater standard in 100 years.

DOE-GJO staff agreed that this groundwater discharge term is important, and explained that a vegetation map for the site has been prepared to allow determination of the location and size of those areas where groundwater is potentially withdrawn by the tamarisk. DOE staff reported that evapotranspiration (ET) rates from tamarisk have been estimated by others, and that this information will be used in conjunction with the vegetation map to estimate the total amount of the local groundwater budget that is lost from the system via ET by tamarisk. DOE also added that if future groundwater flow modeling shows this route of groundwater loss is significant or important, that measures will be taken to better define the annual quantity of this groundwater sink term, if needed.

In follow-up, the Subcommittee asked what information was available regarding the potential for tamarisk to uptake groundwater contaminants at the site. DOE-GJO staff explained that no DOE research is available regarding the uptake of uranium mill contaminants by tamarisk. However, other research has apparently been conducted in New Mexico. DOE staff agreed to obtain this research and distribute it to the Subcommittee members [7].

DOE staff explained that they have considered using the tamarisk as a phytoremediation mechanism of the groundwater contaminant plume. This mechanism would likely not be used alone, but rather in conjunction with other technologies to clean up the contaminated groundwater at the site.

4. River Migration Letter Report [Dated June, 2002] – Greg Smith (MACTEC-ERS)

DOE staff explained that previous Atlas work reported by Mussetter and Harvey (1994) indicated the greatest erosional force is exerted on the Northwest bank of the Colorado River at the Moab site during bank-full flow conditions, which is a flow rate of about 40,000 cubic feet per second (cfs). At higher river flow rates, over-bank releases into the Matheson Marsh lower the velocity and erosional forces on the Northwest riverbank near the pile. Over geologic time, the deposition of alluvial gravels by Moab Wash and Courthouse Wash by armoring the Northwest bank with course outwash, also encourages the Colorado River to maintain a course that is Southeast-ward of the tailings pile.

DOE-GJO review of four aerial photos of the site in the recent past (1944, 1953, 1980, and 2001) suggests that the river channel in the Moab valley has deepened over this period of time. Dissolution of the Paradox Salt formation at depth is likely greatest Southeast of the Colorado River, and should therefore encourage the river to migrate Southeast, away from the Moab tailings pile. DOE-GJO review of a geologic map by the Utah Geologic Survey (Doelling, Ross, and Mulvey, 1995) shows a Quaternary-age terrace gravel (Qat3) is found East of Courthouse Wash and North of Highway 191, about 50 or more feet above the current elevation of the wash. DOE fieldwork has also identified a second and likely younger gravel deposit (No. 2) located at a lower elevation and East of the Courthouse Wash parking lot. Because the younger gravel deposit is located at a lower elevation and South of the Qat3 outcrop, DOE staff suggested that this evidence indicates that during the process of

[7] Subsequent to the July 12, 2002 meeting DOE staff were unable to locate any research information on the ability of tamarisk to uptake uranium mill contaminants. However, some existing DOE research is available for several other plant species to uptake uranium and nitrogen-based contaminants, including: greasewood, four-wing saltbush, carrots, squash, and sudan grass.

down-cutting, the Colorado River has only migrated Southward thru the course of geologic time and therefore away from the tailings pile.

As observed during the morning field tour, Colorado River gravels can be easily identified due to the presence of rounded and sub-rounded igneous and metamorphic clasts that are not present in gravels deposited by Moab Wash.

Subcommittee Comments: River Migration Letter Report – comments provided by Subcommittee members were as follows:

1) *Implications of River Channel Deepening – if the river's channel has deepened over the last 50 years or more, and if this trend continues, then the river flow rate at bank-full condition could increase in the future. Higher bank-full flow rates could result in greater erosional force on the Northwest bank near the tailings pile, which in turn could invalidate any design basis that DOE may employ in an engineering solution for this potential problem. Mr. Smith said that DOE would have to look at the river's cross-sectional area near the pile to determine if higher flow rates would result in higher water velocity and erosional force on the Northwest bank near the pile. He also added that if these higher velocities were real, that both the probability of the higher river flow rates occurring in any given year would be lower and the corresponding return period greater. However, no assessment was made during the July 12 meeting regarding the possibility of channel deepening and higher flow velocities in light of the DOE 200 - 1,000-year engineering stability design mandate.*

2) *Potential for Erosion on Bank Opposite the Point Bar – we agree that the stream morphology of the Colorado River near the Moab Project Site appears to be well represented by a point-bar / meandering stream pattern as outlined on Pattern 4 in the report (Figure 2). However, DOE must remember that this conceptual model for stream morphology dictates that the point-bar side of the meander is an area of active deposition; while the opposite bank is an active area of erosion. For the Moab site, this means the left-hand side or Southeast bank of the river constitutes an area of active deposition, while the right-hand side or Northwest bank of the river is an erosional area. The relative rates of deposition by Moab and Courthouse Washes on the Northwest bank and erosion by the Colorado River in the same area (on its outer bank) are not likely equal or constant over time. This should lead to some migration when the process of one system dominates the process of the other.*

3) *Historic River Migration South of Pile – the report states that South of the tailings pile, the river's channel has migrated only Westward toward Poison Spider Mesa since 1944 (ibid., p. 3). However, review of the map provided in the DOE report (Figure 4) suggests that the Colorado River has migrated both East and West during this time period.*

4) *Other Explanations for Apparent Southern Migration of River Near Pile - it was agreed that in situations where the river is down-cutting its course, that higher terrace gravels would be older than gravels found at lower elevations. However, more than one explanation is possible for the Southern shift observed for the younger gravel deposit No. 2, in that this displacement for the younger gravel deposit may be an artifact of more resistant bedrock and a corresponding cliffs or highlands. The juxtaposition of a resistant topographic high area with the former course of the river may well have limited*

the river's ability to migrate Northward at the time the younger No. 2 gravel was deposited. Based on the current information available, DOE is unable to discern which mechanism is the root cause for the apparent Southern shift of the younger gravel deposit.

5) *Tool to Interpret River Migration: Age Dating of Subsurface River Gravel Deposits – any interpretation of the migration direction of the Colorado River's course thru time via the location of the river gravel deposits would be greatly facilitated with age-dating techniques. Such age-dating may be accomplished thru the use of radio-carbon analysis, should organic matter be found in core samples collected. However, all agreed that the likelihood of finding organic matter in the river gravels is low, considering the high-energy environments in which they were deposited*[8]*. Whether sufficient organic material for dating can be obtained from any overbank (darker detritus) Colorado River sediments should be considered as the cores are examined. In the absence of the latter, superposition may be the only mechanism available to determine the relative ages of the river gravels.*

6) *Need to Map Subsurface River Gravel Deposits – special attention needs to be given to core sampling and determination of vertical profiles of the gravel deposits across the Moab Project Site. Close attention must be paid to gravel clast lithology during all exploratory drilling at the site. From this drilling, maps and cross-sections need to be made of the horizontal and vertical occurrence of subsurface gravels with a source and depositional environment interpretation made where possible based on their clast lithologies. The distinction and mapping of these gravels should be relatively straight forward based on contrasting color, angularity and lithology composition.*

7) *Depth to Bedrock Data – is also important if we are to understand subsurface geology, local groundwater hydrology, and past river migration patterns at the Moab Project Site. DOE staff agreed to review the available information regarding depth to bedrock and types of bedrock formations in the Northern end of Moab Valley. Harvey Merrell volunteered to provide a copy of the geologic log for the Great Lakes Carbon well drilled near the Allen Memorial Hospital*[9]*.*

5. Characterization of Brine Zones Report and Addendum [Dated 6/02 and 6/21/02, respectively] – Don Metzler (DOE-GJO) and Ken Karp (MACTEC-ERS)

DOE staff explained that during the pump test at well PW-01, located off the Southeast corner of the tailings pile, that the up-coning of the deep brine was apparent in the pumping well. However, this well was completed with a long screen interval that extended across both the shallow Silty Sand and the deeper Gravelly Sand layers. Hydraulic stress applied during the pump test resulted in preferential yield from the deeper and more permeable Gravelly Sand layer. Consequently, the brine upconing observed was a largely a product of the pumping from the deeper Gravelly Sand.

[8] Since the July 12, 2002 meeting DOE found wood material in Boring 435 at a depth of about 116 ft bgs. This material has been sent out for Carbon-14 analysis.
[9] Since the July 12, 2002 meeting, Harvey Merrill has provided the geologic log for the Great Lakes Carbon well.

In contrast, DOE's current remediation design calls for groundwater pumping from only the shallow Silty Sand, with the hopes of intercepting only the pollution that impacts the backwater habitat areas along the North bank of the Colorado River. Accordingly, the deeper contamination, some of which is found in the freshwater / brine transition zone, would be allowed to travel under the backwater habitats and discharge to the mid-channel area of the river where it hopefully will undergo significant dilution. Unfortunately, the existing completion of pumping well PW-01 allowed the recent pump test to stress both the shallow Silty Sand and the higher hydraulically conductive deep Gravelly Sand formations. Consequently, the PW-01pump test did not discretely stress only the upper formation in accordance with the current DOE remediation design plans.

For this reason, DOE-GJO installed a new pumping well at the PW-01 cluster that is discretely screened across the Silty Sand. DOE plans on repeating the pump test exercise at this location in early August, 2002. A new observation well was also added at this well cluster to better observe the hydraulic response in the shallow Silty Sand. This new pump test will be done at rates of about 1 to 5 gpm to simulate the aquifer pumpage planned for the pump and treat interceptor well network.

DOE-GJO is also considering use of a hydraulic injection barrier of some kind, in combination with a network of pumping wells in order to better control the upcoming of the deep brine groundwater under the site.

Subcommittee Comments: Characterization of Brine Zones Report and Addendum – comments offered by the Subcommittee were as follows:

1) *Need for Freshwater Equivalent Heads – the groundwater elevations for each well cluster studied in the Brine Zones Report needs to be converted to freshwater equivalent head, so as to better understand vertical gradients at the facility. This is particularly important for VWTs that only measure pore fluid pressure. DOE indicated that they will address this issue in their reporting of Phase II characterization activities.*

2) *Brine Not Encountered in PW-03 Well Cluster: Need for Deeper Investigations – review of the DOE baseline data collected at the PW-03 nested well cluster located in the mill site area suggests that the high TDS water found at a depth of 78 ft bgs in well PZ3D2 is not a brine, but instead groundwater contaminated by the tailing pile. This conclusion is based on the high sulfate-to-chloride (SO4:Cl) ratio (3.25) and the elevated concentrations of ammonia as nitrogen (540 mg/l) and uranium (3.001 mg/l) at this depth in well PZ3D2. It is important to note that at the other two well cluster sites studied in the DOE report, PW-01 and PW-02, that the SO4:Cl ratios decreased with depth to values at or below 1.0 near the brine interface. In contrast, groundwater at the PW-03 cluster exhibited SO4:Cl ratios around 1.0 in the shallow reaches of the aquifer increase with depth to values above 3.0 at a depth of 78 ft bgs. Based on these observations, it is clear that deeper investigations are needed across the mill site in order to adequately define the extent of the tailings contamination and determine its fate in the subsurface. DOE indicated that deeper borings in a number of areas across the property are part of the current characterization effort.*

3) *Need for Complete Understanding of Groundwater Streamtubes - the deep tailings related groundwater contamination seen at the PW-03 well cluster (PZ3D2) coincides*

with the vertical downward freshwater equivalent hydraulic gradients observed previously at this location. This downward gradient was brought to DOE's attention during the last Subcommittee meeting (April 16, 2002). These observations reinforce the need to carefully characterize the vertical hydraulic gradients at the facility before any attempt is made to model the local groundwater system or remediate the local aquifer. DOE plans to incorporate and evaluate all available hydraulic data for analysis and incorporation into the conceptual model.

4) *Agreements Regarding Deep Brine System – during the course of the discussion general agreement was made on several brine related issues, including:*

   a) *Seawater-like Groundwater Quality Indicator – on a preliminary basis the freshwater / brine contact in the subsurface would be indicated where groundwater TDS approaches 35, 000 mg/ l (typical of sea water) and a high chloride content exists. However, a true brine can reach several hundred thousand mg/l TDS such as what might be expected in deeper groundwaters that are in direct contact with the Paradox salt.*

   b) *Brine Transition Zone – the deep brine interface is likely not a sharp or abrupt contact, but instead a zone across which shallow higher quality groundwater transitioned to dense brine at depth. Editorial Note: DOE should define terms used to describe freshwater and transition zone water in addition to brine (≥ 35,000 mg/l).*

   c) *Provenance and Fate of Deep Brine System – based on all the geologic evidence available, it is clear that the deep brine system has discharged to the Colorado River for an extremely long period of time, if not millions of years. It is also clear that the role of the deep brine system is central to the removal and transport of salt rock from the deep Paradox Formation, and creation of the Moab Valley salt collapse structure.*

5) *No Need to Remediate Deep Brine System – in locations where the tailings contamination has impacted the deep brine system, there is no need for active groundwater remediation, based on: 1) the naturally poor quality (high TDS) of groundwater in such intervals, and 2) the high rates of dilution afforded at those locations where the brine system discharges to the Colorado River (main channel area).*

6. Summary of Geology and Groundwater Resources Report: Klondike Flats [Dated 6/02] – Don Metzler (DOE-GJO)

The DOE summary report constitutes a reconnaissance effort to characterize the geology and hydrology resources of the Klondike Flat area. Before actual construction begins, additional studies would need to be completed to obtain necessary detailed information for repository design and construction.

In summary, the DOE report found the Klondike Flat area is exemplified by a large Northwesterly plunging syncline, with an outcrop of the Cretaceous-age Mancos Shale Formation at the surface. This shale formation and geologic structure constitute an ideal location for waste disposal.

The first water bearing formation at Klondike Flat may be the Ferron Sandstone which is the lowest sandstone member of the Mancos Shale. If this interval is dry, the next water bearing zone would be Dakota Sandstone / Cedar Mountain Formations which outcrop at the margin of the syncline. However, it is unlikely that either of these formations could produce enough water for construction demands of a new tailings cell.

To meet the anticipated construction water needs, approximately 200,000 gallons per day would be required. The first aquifer that could likely sustain such a yield would be the Navajo Sandstone. Near/along the axis of the syncline shown in the report, a water supply well would need to be over 2,000 feet deep to reach the Navajo Sandstone. However, artesian pressure is anticipated in this formation. Consequently pumping depths would not be this great for wells completed in the Navajo Sandstone.

Three possible designs are apparent for a tailings repository at Klondike Flat, including an above grade design, a partially above grade design, and a below grade design. For the last two options, clay could be harvested from the excavation into the Mancos Shale to manufacture radon barrier material for the cover system. All three options would allow for construction of a compacted clay liner beneath the tailings embankment to ensure integrity of the repository should the Mancos Shale be somewhat fractured in this area.

Subcommittee Comments: Klondike Flats Geologic And Groundwater Resources Report – comments provided by Subcommittee members were as follows:

1) *Ferron Sandstone, Dakota Sandstone, and Cedar Mountain Formations – it was agreed that these formations are unlikely to yield enough groundwater for repository construction purposes. However, one or all of these shallow intervals may be useful for purposes of establishing a groundwater monitoring network at a new tailings repository.*

2) *Future Studies for State Escrow Funds – previous discussions between the State of Utah and DOE-GJO examined the possibility of using State escrow monies for additional hydrogeologic investigations of the Klondike Flat area. When questioned if we had reached a point where additional investigations would be useful, DOE staff suggested that decision be deferred until a later date.*

3) *Thickness of the Mancos Shale at the Klondike Site –appears to be sufficient for repository siting and clay liner / radon barrier construction.*

4) *Need for Further Characterization: Moab Airport Water Well – additional research needs to be done to determine the producing aquifer / horizon, and yield of the water supply well at the Moab Airport, in order to protect this resource of public drinking water.*

5) *Possible Plans for Future Characterization - when the time arrives for these additional studies, DOE staff explained that the next step would be to drill three shallow water wells to determine which formations contained the first saturated interval (Ferron Sandstone, Dakota Sandstone, and/or Cedar Mountain Formation). Groundwater heads would be measured to determine local groundwater flow direction, and groundwater samples would be collected to determine background groundwater quality.*

7. Subcommittee Action Items – at the conclusion of the meeting, several action items were reviewed. Other action items became apparent during preparation of the meeting minutes. All of these are listed below:

   A. Installation of New Shallow Alluvial Well at Bedrock Well 434 – DOE will install a shallow alluvial well screened across the gravel zone encountered at a depth of about 52 to 60 ft bgs. This well will be used in combination with bedrock well 434 to determine local vertical groundwater flow directions.

   B. Tamarisk Uptake of Uranium Tailings Contaminants – DOE agreed to provide the Subcommittee with copies of the New Mexico research regarding uptake of uranium mill tailings contaminants by tamarisk[10].

   C. Great Lakes Carbon Well Geologic Log – Harvey Merrell agreed to provide a copy of this log to DOE-GJO staff[11].

   D. Geologic Logs and Well Completion Diagrams – upon completion of any new boring or well, DOE will provide copies of geologic logs and well completion diagrams to all members of the Subcommittee. This information will also include final survey coordinates for each well / boring. Core samples from ongoing site investigations should be preserved for future review by interested parties.

   E. New Letter Reports or "Calc Sets" for On-going Investigations - will be provided Subcommittee members to help them stay abreast of latest developments in DOE-GJO on-going investigations at the site, including [12]:

      1) New Brine Pump Tests at PW-01 (Scheduled for Early August, 2002) – all new hydraulic response information, pump test details, and groundwater quality data collected will be provided the Subcommittee.

      2) Groundwater and Tailings Pile Characterization – all geologic, hydrologic, and groundwater quality information collected during the course of this study will be provided to the Subcommittee. Information on tailings pore fluids head, quality and / or geochemistry of tailings solids will also be provided.

      3) River Migration Potential – special attention will be given to identification of clast lithology for all gravel intervals found in subsurface core samples. Maps and cross-sections will then be prepared to identify and distinguish the vertical and horizontal location of gravels deposited by either the Colorado River or Moab Wash. Organic matter (e.g. woody material) would be collected for possible radiocarbon dating.

      Maps, diagrams, and other figures will be included in these Letter Reports as necessary to describe the new information gathered by the investigation in question. Written descriptions and interpretations made by DOE will also be included. Due to their inter-

[10] Since the July 12, 2002 meeting, DOE has been unable to locate research information on the ability of tamarisk to uptake uranium mill contaminants, see Footnote 7, above.
[11] Harvey Merrill has already provided this information to DOE-GJO.
[12] This DOE information will be provided to Subcommittee members before the next meeting, scheduled for November 6, 2002 in Moab, Utah.

related nature, information collected by one study could be of use in another investigation, be it either the Brine Pump Test, Groundwater / Tailings Pile Characterization, and /or River Migration Potential. Consequently, close coordination will be required between these three studies as the overall on-going site characterization investigation evolves.

8. Next Subcommittee Meeting – to be held in Moab on Wednesday, November 6, 2002. Agenda for this meeting will be determined later as the above-mentioned investigations evolve and more is known about the characterization of the facility.

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